

Science is an integral part of culture. It's not this foreign thing, done by an arcane priesthood. It's one of the glories of the human intellectual tradition.

Stephen Jay Gould (1941–2002)

POLICY

Smoking Bans Yield Long-Term Benefits

When it comes to linking cigarette smoke to heart attacks, one might assume that such a link would apply only as long as one is smoking or being exposed to secondhand smoke. That's not necessarily true, however, at least according to a follow-up study of people living in and around Pueblo, Colorado. In the 2 January 2009 issue of *Morbidity and Mortality Weekly Report (MMWR)*, researchers reported that hospitalizations in Pueblo for acute myocardial infarction (AMI) showed a steady, continuous decline three years after the city introduced a smoking ban in all public buildings.

In November 2005, researchers first began to report that a smoking ban in all public buildings in Pueblo was associated with a significant reduction in the number

of hospitalizations for AMI [see *EHP* 114:A154 (2006)]. In the 18 months after the ban came into force, the number of such hospitalizations fell 27%, from 257 to 187 per 100,000 person-years. Only a small reduction was seen for the population living outside the city limits, and no reduction was seen in neighboring El Paso County—areas unaffected by the ban.

The new figures published in *MMWR* examine the three years since the smoking ban began and show that the number of hospitalizations for AMI has continued to decline to 152 per 100,000 person-years, says Robert Alsever, medical director for health information at the Parkview Medical Center in Pueblo and first author of the update report. That's a 19% reduction over the figure for the first 18 months after the ban began and a total 41% reduction since the ban started, he says. The point at which these improvements will level off remains to be seen.

In a review published in the February 2009 issue of *Preventive Medicine*, Lorenzo Richiardi and colleagues noted that at least 10 studies in the United States and Europe had reported a reduction in the number of hospital admissions for AMI in the months following the introduction of regulations banning smoking in public places. The decreases observed ranged from 8% in New York State to 40% in Helena, Montana. Specifically, the Helena study found a 40% decline in hospital admissions for AMI during a 6-month smoking ordinance within Helena city limits; however, this was a relatively small population study.

An editorial note that accompanies the *MMWR* report observes that a meta-analysis of seven other studies and one unpublished study yielded a pooled estimate of a

19% reduction in AMI hospitalization rates after implementation of public smoking bans. Three studies suggested these reductions were more pronounced among nonsmokers than among smokers.

The Pueblo study, however, did not assess what portion of the observed decrease in hospitalizations could be attributed to reduced secondhand smoke exposure among nonsmokers or to quitting among smokers. Even though the prevalence of smoking dropped in Pueblo County as a whole, the difference over time was not statistically significant. As the editorial note explains, “the ecologic nature of this study precludes definite conclusions about the extent to which the observed decline in AMI hospitalizations in the city of Pueblo was attributable to the smoke-free ordinance.”

One concept that may begin making its way into tobacco control policies and programs is that of “thirdhand smoke,” which refers to the chemicals in cigarette smoke that settle on the surfaces inside a home. Jonathan Winickoff, a pediatrician at the Dana-Farber/Harvard Cancer Center, is one of a growing number who believe these deposited chemicals pose a hazard to occupants' health days after a cigarette is stubbed out. “Children are particularly likely to come into contact with this thirdhand smoke,” explains Winickoff. “The chemicals in smoke may stick to objects for many days and are gradually released back into the air, so infants and children breathe in and ingest tobacco toxins as they crawl over, mouth, and play on contaminated surfaces.”

In a survey published in the January 2009 issue of *Pediatrics*, Winickoff's team asked U.S. adults to describe their beliefs about the health effects of second- and thirdhand cigarette smoke. Many people reported believing that thirdhand smoke is far less of a health concern for children than secondhand smoke. Those who did report believing thirdhand smoke poses a hazard to children were more likely to enact strict smoking bans inside their homes. Says Winickoff, “These findings suggest that if more people understood the dangers of thirdhand smoking, especially to their children, we might see more nonsmoking policies adopted in the home.” —Adrian Burton



ENDOCRINE DISRUPTION

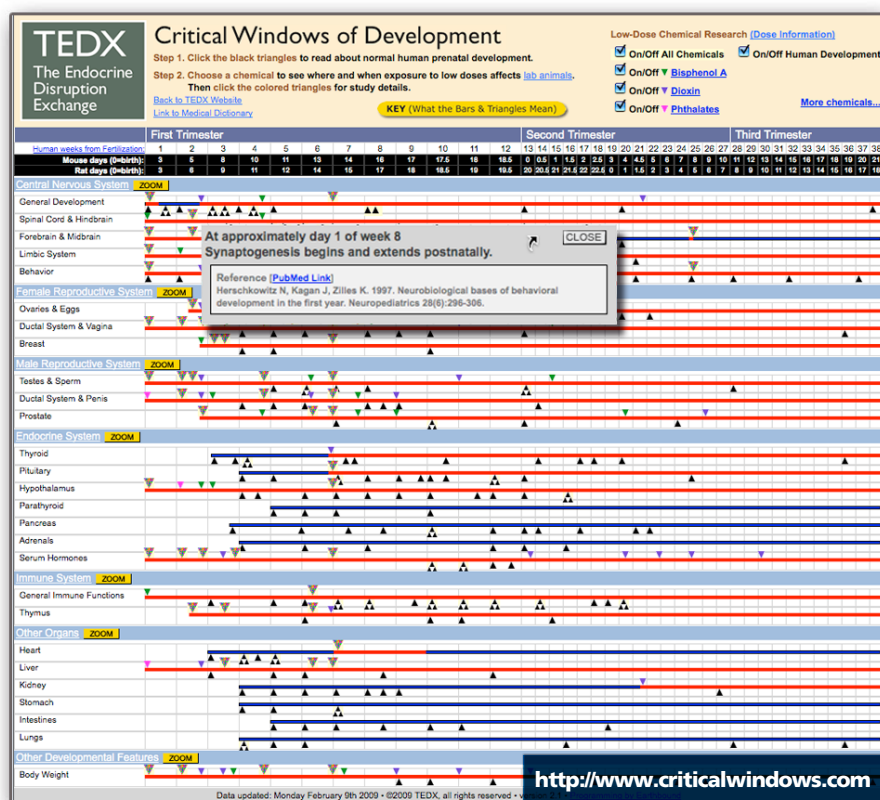
Developmental Picture Window

The concept of endocrine disruption emerged in the early 1990s with the observation that natural and industrial compounds were interfering with sex hormone signaling, thereby adversely affecting male and female reproductive health. Since then, many endocrine-disrupting chemicals (EDCs) have been identified, and the field now comprises thousands of studies encompassing virtually every system in the body. On 10 February 2009, the Paonia, Colorado-based nonprofit group The Endocrine Disruption Exchange (TEDX) unveiled the Critical Windows of Development timeline (<http://www.criticalwindows.com>). The timeline provides a snapshot of the state of the science of when organs and systems develop, when they are vulnerable to particular EDC exposures, and what effects have been observed.

Endocrine disruption is not confined to the reproductive system because virtually every system in the body is hormonally responsive. The effects can differ depending on when exposure occurred. For example, according to the timeline, prenatal exposure in mice to bisphenol A (BPA) at gestational days 11.5–18.5 is associated with abnormal fetal egg cell development whereas exposure at gestational days 15–18 is associated with structural changes to the vagina.

Theo Colborn, president of TEDX, first conceptualized condensing the body of EDC literature into a user-friendly graphic format. Despite Colborn's optimism concerning the timeline's feasibility, it took several years to figure out how to present the data visually. "We had the data here, and we had everything in boxes, but displaying it in the picture we wanted to create was complex," says Colborn. An early attempt involved an extraordinary expanse of butcher paper; a collaboration with Carol Kwiatkowski, now executive director of TEDX, helped bring Colborn's vision to fruition. "As far as we know, there's nothing out there like it," says Kwiatkowski, who organized and then funneled the research into a database before finding the web developer who could translate it into the desired visual display.

The display comprises a series of horizontal bars, each depicting a specific system or organ for the full 38 weeks of human pregnancy. Corresponding time points in rodent development are indicated along the top of the screen. Tick marks along the bars



indicate studies done at specific time points corresponding to points in normal human development. Another series of tick marks indicates EDC studies performed in the laboratory. Clicking on a mark brings up a concise summary of the study details with a link to the PubMed record.

All chemical studies notated on the timeline must be original research using rodent or human cells or tissues. Exposures of parts per million or less to an EDC must have occurred during a time point equivalent to some point in human prenatal development. "We wanted to keep it within a range [representing the point] where we know from the literature on ambient exposures and monitoring studies that humans might be exposed," says Colborn. The timeline is currently populated with all existing BPA studies that meet the criteria for inclusion; staff are still plotting dioxin and phthalate studies. New studies will be inserted upon publication, and more chemicals will be incorporated into the timeline in the coming year.

The timeline, which is free to all users, fills several needs at once. "One of the needs that has become apparent over the years has been just a basic reference for normal development in both humans and rodent models," says Kris Thayer, a health science administrator at the NIEHS. To begin to grasp how various systems are affected

by endocrine disruption, it is necessary to know when those systems are developing. "What Theo has done is to develop a graphic tool—it's very visual, very interactive, and very well referenced—so you can easily see everything in one place," says Thayer.

Jerry Heindel, a scientific program administrator at the NIEHS, says the timeline could be useful in determining areas where research is needed and how to plan new studies. "Even a cursory examination of the tick marks that show when experiments have been done provides a nice overview of the timing of studies throughout development," he says. "This information can then be used to refine the timing, doses, and end points of future studies."

Colborn also hopes the timeline will inspire scientists to take a broader view of endocrine disruption and possibly promote collaboration across systems. Researchers tend to focus on one system or organ at a time, she says, and as a result a lot of information that could be gleaned from carefully controlled experiments is never gathered.

"I think the timeline will be very useful for researchers [from many disciplines], especially as people cut across different biological systems," says Thayer. "The information on the timeline is contained in reference books and research journals, but it's very handy to have it all in one place."

—Julia R. Barrett

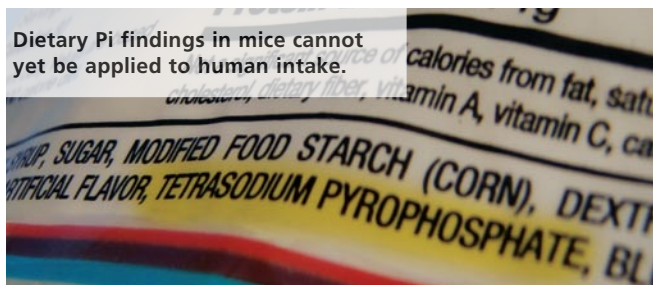
DIET AND NUTRITION

Phosphate Linked to Lung Cancer in Mice

Inorganic phosphate (Pi) is a vital component of membrane phospholipids and nucleotides, both of which provide energy and serve as components of DNA, RNA, and phosphorylated intermediates in cellular signaling. Most living organisms need some Pi to survive, but a diet high in Pi may contribute to lung cancer, according to an animal study reported in the January 2009 issue of the *American Journal of Respiratory and Critical Care Medicine*. The new study by Myung-Haing Cho and colleagues at Seoul National University finds that dietary Pi levels equivalent to those typically found in the modern Western diet were linked with increased lung tumor growth and progression in mice. “The study is the first to demonstrate that dietary phosphates alter the course of cancer in a relevant animal model,” says coauthor George Beck, an assistant professor of endocrinology at Emory University.

Cho and colleagues cite surveys showing that the amount of Pi added to processed foods and beverages increased by about 17% between 1983 and 1993 and may have continued to increase since that time. Pi occurs naturally in foods including cow’s milk, soy products, corn, wheat, eggs, legumes, and chocolate, and food manufacturers also add Pi to many products—including soft drinks, baked goods, cheese products, ice cream, candy, ketchup, mayonnaise, hot dogs, processed meats, and frozen pizzas—to improve water retention and texture.

The researchers selected *K-ras^{LA1}* mice to study the effects of dietary Pi on lung tumors. *K-ras* is the most frequently mutated gene in human tumors, and *K-ras^{LA1}* mutations result in aggressive tumors that resemble non-small cell lung cancer in humans. According to the American Cancer Society’s *Cancer Facts & Figures 2008*, non-small cell lung cancer accounts for 87% of all lung cancer cases. One-month-old mice were fed a lower-Pi diet containing 0.5% phosphorus or a higher-Pi diet containing 1.0% phosphorus (Beck says the latter reflects a moderately elevated yet normal human intake). After 1 month, mice on the higher-Pi diet



had twice as many tumors overall as those on the lower-Pi diet and moreover showed a near 3-fold increase in tumors larger than 1.5 mm in diameter (an arbitrary measure chosen to indicate ease of detection).

Changes were also seen at the molecular level. Higher Pi intake was associated with a 3-fold increase in the activity of Akt kinase (a cell-signaling protein that aids tumor growth and makes cancer cells resistant to anticancer therapies) and a doubling in the amount of NPT-2b (a phosphate transport protein). The higher-Pi diet also lowered levels of tumor suppressors including PTEN.

Nevertheless, Beck believes it’s too soon to sound the alarm about Pi-rich foods. “We need to show similar changes in humans before telling people to limit dietary Pi,” he cautions. Such studies should track long-term dietary habits to see if low- and high-Pi intakes relate to lung cancer incidence in human populations. “It would also be interesting to test whether low-Pi diets make existing cancer drugs more effective,” Beck adds.

John Heffner, a pulmonary and critical care physician and director of medical education at Providence Portland Medical Center, says the findings could shed light on questions such as why some smokers develop lung cancer later than others or not at all. Heffner agrees that it’s premature to cut back on Pi-containing food additives or to limit intake of foods that are naturally high in the mineral. “Before warning the public,” he says, “the Food and Drug Administration should review the increase in dietary Pi in light of studies like this.” —Carol Potera

Joseph Tarr/EHP

The Beat by Erin E. Dooley

Arsenic Worse for Toddlers?

Arsenic contamination of drinking water is a major global health problem, with 100 million people exposed to levels above the WHO’s guideline of 10 µg/L. A study in Bangladesh has found that 18-month-old children were less able to rid their bodies of the toxic metal compared with 3-month-old breastfed infants. Reporting

A toddler in Bangladesh

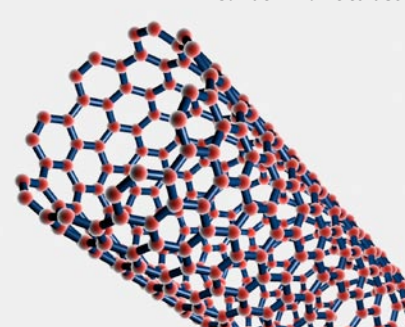


online 6 January 2009 in *Toxicology and Applied Pharmacology*, the researchers found a marked increase in the metabolite methylarsonic acid, which has been linked with a range of adverse health effects. The likely basis for these findings: post-weaning metabolic changes and greater intake of arsenic-tainted water and food instead of mother’s milk, which may confer some additional protection against arsenic poisoning.

Spicy Cleanup Option for Nanotubes

Carbon nanotubes, super-strong materials made of 1-atom-thick rolls of graphite, have outstanding electronic properties and are widely used in computers, TVs, and other products. Accidental production-related spills of nanotubes and the sheer ubiquity of these materials could someday pose a major environmental burden. Researchers reporting in the 12 November 2008 issue of *Nano Letters* now propose a “hot” solution to nanotube pollution: carbon nanotubes can be broken down by horseradish peroxidase, an enzyme long used in immunology research. Although more study is needed to refine the biodegrading process and identify potential by-products, the

Carbon nanotubes



method has already proved successful under environmentally relevant conditions.

NO_x Cap Pays Off

The 2008 annual report of the NO_x Budget Trading Program, a cap-and-trade partnership between federal and state governments, revealed that 2007 summertime NO_x emissions in 20 eastern states and the District of Columbia were down 60% from the year 2000 and down 74% from 1990. These reductions have helped curb ground-level ozone by 10% since the program’s inception in 2003. NO_x—mixtures of

AP Photo/Pavel Rahman; Spame/Shutterstock

CLIMATE CHANGE

California's 2020 Vision

As the source of 1.4% of the world's greenhouse gas (GHG) emissions and 6.2% of U.S. emissions, California is a significant actor on the global climate stage. In the coming decades, if current scientific thinking proves correct, California and many other parts of the world could face climatic fallout in the form of rising sea levels, more wildfires, water shortages, and pollution-aggravating heat waves. These changes, in turn, could incur immense public health costs and other economic losses. Against this backdrop, the Golden State has adopted a comprehensive plan—unprecedented in scale and scope—designed to reduce GHG emissions substantially by 2020. The long-range goal is to achieve emissions that are 80% below 1990 levels by 2050.

On 11 December 2008, the state's Air Resources Board (ARB), a department of the California Environmental Protection Agency (CalEPA) and the agency responsible for protecting air quality, approved the "Climate Change Scoping Plan" for reducing the state's carbon footprint. The plan, developed by the ARB in coordination with representatives from other agencies, aims to reduce GHG emissions back to 1990 levels over the next 11 years; this means cutting emissions by about 15% from today's "business-as-usual" levels. The ARB's scientific staff predicts the plan's measures will reduce the state's GHG annual emissions by a total of 174 million metric tons. Development of the plan was a central requirement of AB 32, the state's Global Warming Solutions Act of 2006.

Pivotal to the plan is a cap-and-trade program that will cover 85% of the state's GHG emissions and give industries a financial incentive to reduce those emissions. By setting a clear, mandatory cap on emissions, the plan allows the market itself to identify the most cost-effective ways to achieve that limit. Tradable emission "allowances" or permits are then distributed in an amount that equals the total emissions permitted by the cap. Complementing the cap-and-trade program will be a mix of strategies that combine technology-forcing performance standards, fees, and other policies.

The California program is designed to work with the Western Climate Initiative (WCI), a group of states and provinces working collaboratively to reduce GHG levels on a regional scale. Rather than give allowances away for free, the WCI plans to auction at least 10% of permits at the outset while allowing other states to auction more if they choose. California plans on eventually auctioning all permits, perhaps as soon as 2016. "These auction revenues could net anywhere from one to five billion dollars or more annually by 2020, helping to fund the transition to a 'green economy,'" says Bernadette del Chiaro, an energy analyst for the advocacy group Environment California.

Other key features of the California plan include a requirement for utilities to generate one-third of their electricity from solar, wind, and geothermal sources by 2020; implementation of standards for low-carbon fuels, cleaner cars and trucks, and energy- and resource-efficient construction; and full deployment of the Million Solar Roofs Initiative, an incentive program aimed at installing 3,000 megawatts' worth of new rooftop solar capacity by 2017. The complete plan is available at <http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf>.

"We believe that market structures like cap-and-trade are essential for businesses to meet their obligations until green technology comes to market," adds Amisha Patel, policy advocate for climate change and energy issues for the California Chamber of Commerce. However, the plan has not received universal praise. The 12 December 2008 *Los Angeles Times* quoted James Duran, chairman of legislative affairs for the California Hispanic Chambers of Commerce, calling the plan "an economic train wreck waiting to happen" as far as small businesses go.

The regulations and legislation tried out in California will likely be watched closely by the new White House. "What we do here will resonate and will have repercussions on the kinds of approaches and programs that the Obama administration will work to implement," says ARB spokesman Stanley Young. "We are very conscious of the leadership role that we've got, and we want to develop a program that will integrate well with any federal program." —Graeme Stemp-Morlock

nitrogen and oxygen that have been linked with climate change, acid rain, and ozone pollution—are emitted mainly by automobiles, industry, and power plants.

Selecting Crops to Slow Warming

Compared with natural vegetation, agricultural crops generally reflect more sunlight into space. A 27 January 2009 *Current Biology* report suggests that, by selecting crop varieties that better reflect sunlight, summer

temperatures could be lowered by more than 1°C throughout much of central North America and Eurasia. The authors estimate that such a reduction would be equivalent to seasonally offsetting around 20% of the warming projected to occur in those regions by 2100. The researchers believe this low-cost intervention could temper the impact of heat waves and droughts, and that further improvements could be made by breeding more reflective plants or by genetically modifying plants to bolster their reflectivity.

LEED Progress Report

Green construction may be paying off, according to the December 2008 *Green Building Impact Report* produced by Greener World Media. The report shows that the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system has become a fixture of the mainstream building industry. Although the report cautions that more progress is needed if LEED is to contribute to emissions reductions in a meaningful way, initial forays are encouraging. By 2020 LEED-certified nonresidential buildings

could result in energy savings representing about 115 million tons of avoided CO₂ emissions each year. Other LEED benefits include improved indoor air quality and savings in water, land, materials, and resources.

CA Green Chemistry Initiative

In December 2008, the California EPA debuted its Green Chemistry Initiative policy recommendations to promote the development and use of safer chemicals in the state's industries. The initiative entails six actions: a systematic, science-based evaluation of chemicals of concern as well as their green alternatives; an online database of chemical toxicity and hazards; an online product ingredient network that discloses chemicals used in products while protecting trade secrets; a program to orient more business sectors toward pollution prevention rather than cleanup; green chemistry workforce training and education; and a system of metrics and tools for rating consumer products. It's now up to the state to start the transition and oversee progress in the months ahead. Implementation of the first two actions will begin in 2011.

Crops such as certain wheat species are highly reflective.

